PROBLEMATICAL MICROFOSSILS FROM THE SILURIAN OF IRELAND AND SCOTLAND

by ANNALISA FERRETTI, CHARLES HEPWORTH HOLLAND *and* ERIKA SYBA

ABSTRACT. Problematical microfossils are described from the Silurian of the Dingle Peninsula, County Kerry, Ireland and from a clast in the Old Red Sandstone Greywacke Conglomerate of the Midland Valley of Scotland. They are assigned to *Sandvikina* under the new specific name *conica*. The Irish material includes also single specimens of *Sandvikina* sp. and *Regnellia camera*. All these microfossils, which appear to be closely related, are here assigned to the new family Regnellidae, which, on present evidence, is characteristic of the Silurian.

IN 1987 Syba found a single fossil in a thin-section of a clast from the Old Red Sandstone of the Scottish Midland Valley. Its conical appearance with transverse partitions had suggested that it might possibly be a cephalopod. However, its maximum dimension is only *c.* 2 mm, and there is no indication of a siphuncle; clearly another attribution was needed. It resembled *Salterella* in which shearing might have produced the marginal bending of the partitions, but E. Yochelson (pers. comm.) indicated that this was not the case. N. H. Nitecki (pers. comm.) confirmed that our specimen was not any of the plant or animal problematica known to him. S. Bengston (pers. comm.) suggested that the fossil was possibly a spine or sclerite (he was looking at a photograph of the single Scottish specimen only), though he would not call it a tommotiid on the present evidence.

In 1990 Ferretti was working on the microfacies of some Silurian limestones from the Dingle Peninsula, Country Kerry. Her thin-sections revealed material evidently the same as the Scottish microfossil already referred to. Subsequently she has collected more material. In a paper by Lauritzen (1974) describing new microfossils from the Llandovery of the Oslo region one of the forms referred to there appeared to be clearly related to our original enigmatic fossil; the other is the same as one of those described by Regnéll from the Swedish Silurian in 1947, and which occurs in the Irish material.

STRATIGRAPHICAL SETTING OF THE SCOTTISH SPECIMEN

The basal Lower Old Red Sandstone Greywacke Conglomerate is exposed in a series of discontinuous outcrops just north of, and parallel to, the Southern Uplands Fault. It has previously been regarded as forming the base of the Devonian (House *et al.* 1977). Although fossil evidence had been absent from the conglomerate and associated sandstones, Thirwall (1988) dated a major felsite intruded into the Greywacke Conglomerate at approximately 412 Ma, which would suggest its depositional age at no later than latest Silurian.

The composition of the Greywacke Conglomerate is markedly uniform, with fine to coarse sandstones forming the majority of the clasts at any one locality. The sandstone clasts are compositionally immature arenites and wackes, initially deposited as turbidites. These and other clast lithologies are similar to those found in the Ordovician (upper Llandeilo to ?Ashgill) and Silurian (Llandovery to Wenlock) of the Southern Uplands. This led many previous authors to suggest that the source for the Greywacke Conglomerate lay there.

A re-appraisal of the sedimentology of the Greywacke Conglomerate has shown the sequence to be characterized by small (2 km length) vertically stacked proximal alluvial fan sediments deposited

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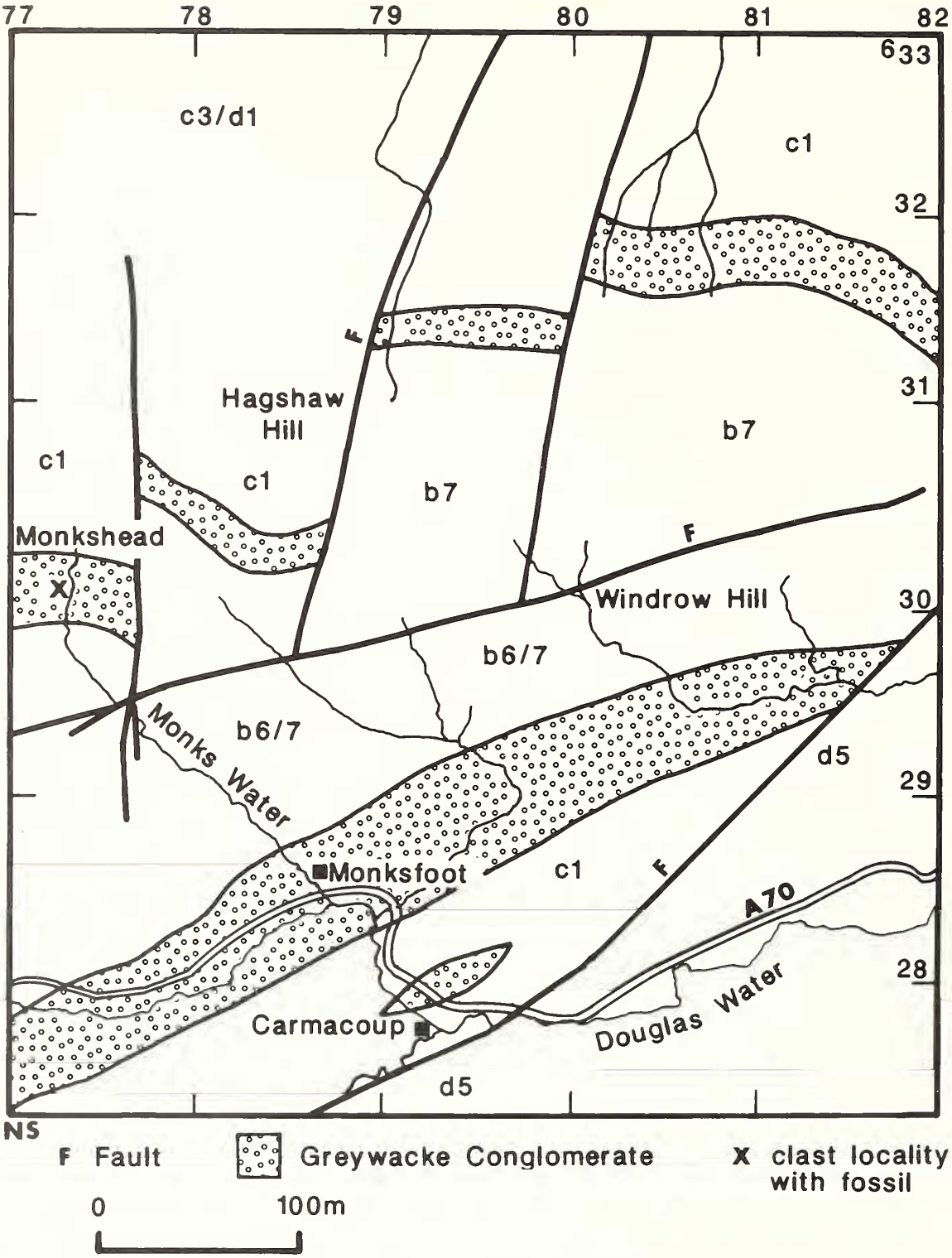
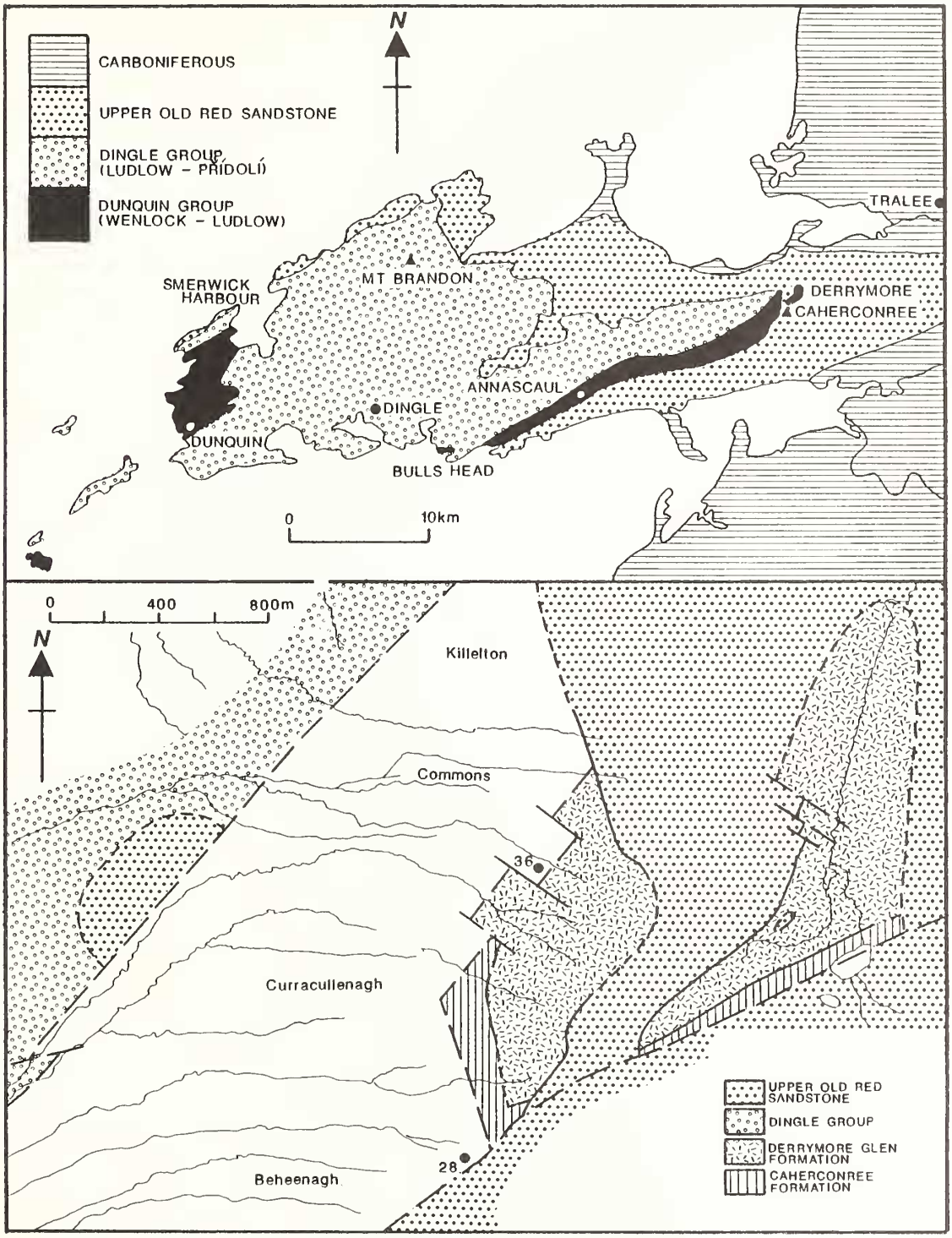


TEXT-FIG. 1. Geological sketch map of part of the Midland Valley of Scotland to show locality from which the clast was collected.



TEXT-FIG. 2. Geological sketch map of the Dingle Peninsula to show setting of the Annascaul inlier. Details of the area at the north-eastern end of the inlier with Parkin's (1976) localities 28 and 36 referred to in the text.

in a series of separate north–south trending basins, each with one dominant fault-controlled margin towards the east (Syba 1989). This work also showed that the petrography and geochemistry of the greywacke clasts could not easily be matched with rocks in the Southern Uplands. This led to the suggestion that the source of the Greywacke Conglomerate was a cover of greywacke within the Midland Valley. The petrographical and geochemical analysis showed that the tectonic setting for the greywacke flysch deposits ranged from passive margin (near Girvan, approximately 60 km southwest of the Hagshaw Hills) to active continental margin. The presence of passive margin-type sands indicated that the source for the greywacke conglomerate may have been accreted to the Midland Valley prior to or during the obduction phase of the Ballantrae ophiolite (Tremadoc-Arenig). The age of the sedimentary sequence which gave rise to the Greywacke Conglomerate is of clear importance in deciphering the relationship of the source to the Laurentian margin. The single fossil referred to here was found within a sandstone clast from the Hagshaw Hills. The clast was collected from *c.* 53 m above the base of the conglomerate at a small exposure (NS 773301) just west of Monks Water (Text-fig. 1).

STRATIGRAPHICAL SETTING OF THE IRISH SPECIMENS

The Dingle Peninsula, County Kerry (Text-fig. 2) provides the richest Silurian shelly faunas to be found in Ireland. This is especially so in the western Dunquin Inlier (Holland 1988). The shelly fauna of the Annascaul Inlier, described in detail by Parkin (1976), is confined to the Ballynane Member near the top of the late Wenlock Annascaul Formation, and to a younger formation in part of the Ludlow sequence. At the mountainous eastern end of the inlier, on the western slopes of Caherconree, there are local limestones within the tuffaceous Ballynane Member.

Siveter (1989) described a rich trilobite fauna from two small exposures, separated by a little over one kilometre of unexposed ground. These were discovered in the nineteenth century by officers of the Geological Survey, and described as 'dove coloured limestone' and 'grey crystalline limestone' (localities 28 and 36 of Parkin).

A considerable quantity of material from the latter (108 samples) has been examined by Ferretti which has yielded the microfossils described below. The grey limestone is a crinoidal-trilobite silty wackestone to packstone, redeposited in, and embedded by, a terrigenous siltstone. The matrix of the limestone is lime mud with sporadic sparry cement among bioclasts.

Parkin (1976) regarded the Ballynane Member as likely to be upper Wenlock in age; its possible extent into the Ludlow is constrained by the overlying Caherconree Formation which is of middle Gorstian age. Aldridge (1980), on conodont evidence, suggested that Locality 28 might be of Wenlock age and Locality 36 of Ludlow age. The best trilobite evidence suggested a 'mid/late Wenlock to earliest Ludlow' age (Siveter 1989).

SYSTEMIC PALAEONTOLOGY

PROBLEMATICA

Family REGNELLIDAE fam. nov.

Diagnosis. Conical to cylindrical microfossils with relatively numerous transverse partitions.

EXPLANATION OF PLATE 1

Figs 1–3. *Sandvikina conica* sp. nov. 1, Institute of Palaeontology, University of Modena no. 24211, holotype. Dingle Peninsula; Ballynane Member; the basal cone and empty distal portion are clearly seen, ×65. 2, Modena no. 24212. Ballynane Member, ×65. 3, University of Glasgow no. 1-H-4. Midland Valley of Scotland; Greywacke Conglomerate, ×75.

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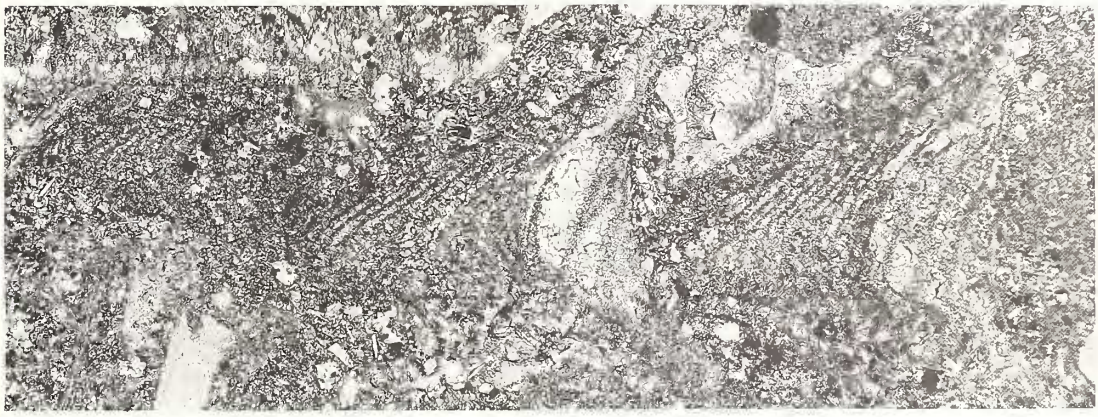

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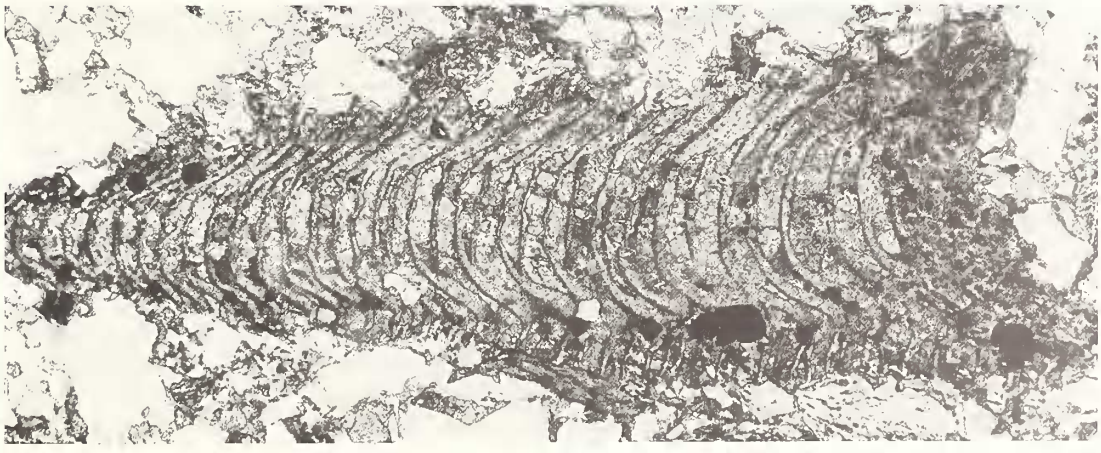

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Discussion. The various microfossils referred to below appear to be closely related. Regnéll (1947) was the first to give descriptions. One of the two forms to which he referred was subsequently given the generic name *Regnellia* Lauritzen, 1974.

Genus SANDVIKINA Lauritzen, 1974

Type species. Sandvikina brachiata Lauritzen, 1974.

Emended diagnosis. A microfossil up to about 5 mm in length, in section comprising a basal conical portion (Pl. 1, fig. 1) with distally concave transverse partitions and an empty distal portion which widens considerably in comparison with the basal cone.

Discussion. Lauritzen (1974, p. 704) referred to a trapezoidal-shaped microfossil with complex wall structure. Our additional material suggests that the former may be an accident of preservation in the section, and the latter is not so characteristic of other forms we place in the same genus.

Sandvikina conica sp. nov.

Plate 1, figs 1–3; Plate 2, figs 1–3

Holotype. Institute of Palaeontology, University of Modena, no. 24211 (in thin section); limestone in Ballynane Member, Annascaul Formation; Dingle Peninsula, County Kerry; Parkin (1976), locality 36; latest Wenlock or possibly earliest Ludlow.

Other material. Institute of Palaeontology, University of Modena, nos 24212–24220, 24223; locality as for holotype. Hunterian Museum, University of Glasgow, P 1380; clast from Greywacke Conglomerate; Hagshaw Hills, Midland Valley of Scotland. All material is in thin sections.

Diagnosis. As for genus, but additionally concave partitions of basal cone bend back at outside, and wall of distal portion is a network.

Description. Though oblique sections of a cylinder would produce a cone, there are sufficient specimens of sufficient similarity to suggest that the basal portion really is conical. Its cross-section remains unknown. Dimensions are given in Table 1. Some transverse partitions anastomose; sometimes the single partitions have spine-like terminations. The wall of the distal portion appears to be composed of two distinct layers, as revealed in all the thin sections. There are never single lines as would be expected in a 'planar' net but rather fragments of a chain. In Modena 24213 (Pl. 2, fig. 3) the inner wall seems to be continuous, even if this represents a particular section of the organism. Modena 24220 (Pl. 2, fig. 1) shows a wall in the distal portion with oblique portions of network tangential to it. A single fragment of the net (letter c in Text-fig. 3; Pl. 2, fig. 2) clearly shows three different levels, two of which (*a* and *b*) are calcareous, but with different crystal sizes, and a third (*c*) which is silicified.

Discussion. Regnéll (1947, fig. 2) illustrated what appears to be an identical form, though Lauritzen referred only to his cylindrical material. *Sandvikina brachiata* Lauritzen, 1974, was described and illustrated as having a layered wall structure in both portions. In this respect it differs from *S. conica.* In the basal cone, referred to by Lauritzen (1974) as 'the outgrowth', the transverse elements are

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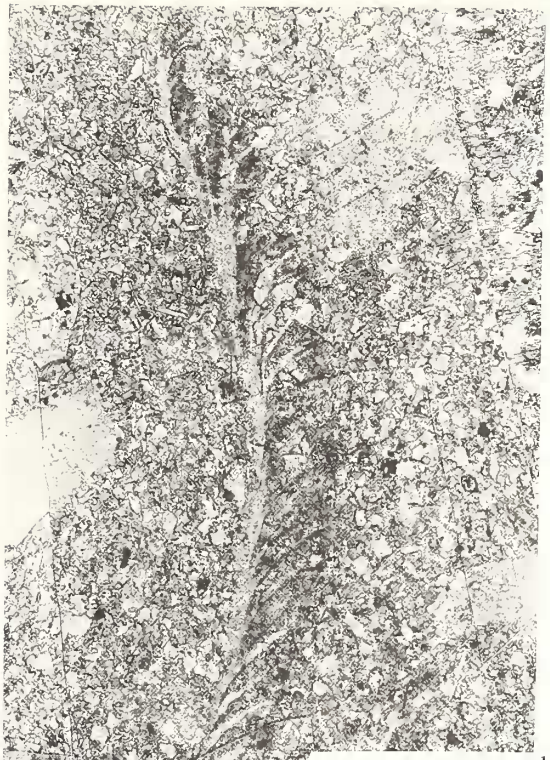
EXPLANATION OF PLATE 2

Figs 1–3. *Sandvikina conica* sp. nov. 1, Institute of Palaeontology, University of Modena no. 24220. Ballynane Member; fragment of distal portion, × 55. 2, Modena no. 24223. Ballynane Member; three different levels are recognizable, two of which are calcareous (*a* and *b*) and one that has been silicified (*c*) × 55. 3, Modena no. 24213 and 24214. Ballynane Member; the distal portion of these specimens is very well developed, × 35.



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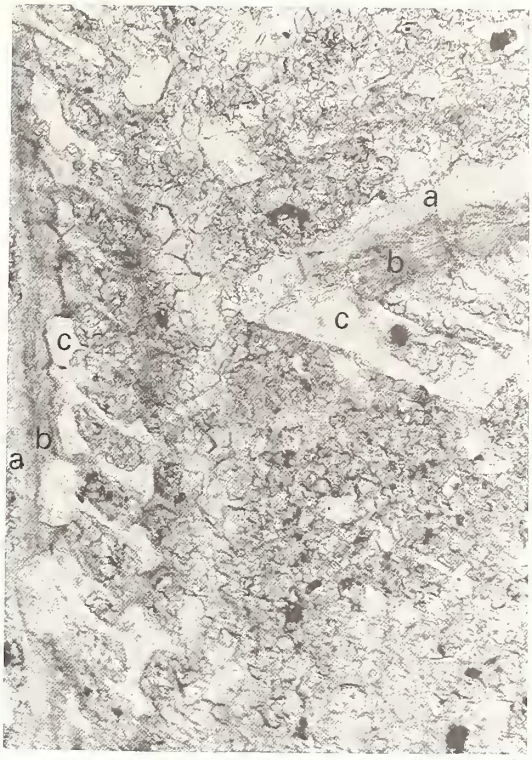

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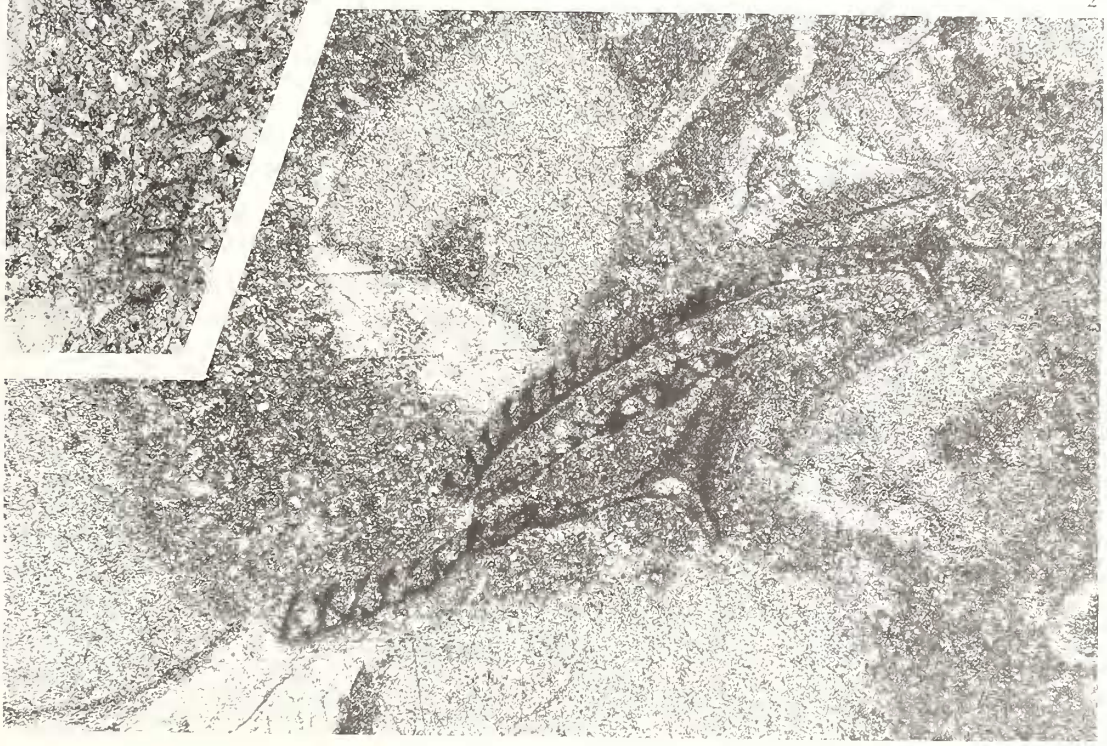

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TABLE 1. Measurements of specimens of *Sandvikina conica* sp. nov. from Ireland taken from thin sections and therefore approximately orientated. In some cases accurate measurement is difficult and some specimens are incomplete. Specimens numbers as indicated in the text.

Specimen number	Total length (mm)	Length of basal cone (mm)	Number of transverse partitions	Angle of increase of basal cone	Angle of increase of distal part
24211	2·2	1·0	27	20	—
24212	5·2	2·0	26	21	—
24213	2·0	0·2	5	17	60
24214	2·0	0·5	—	19	90
24215	—	1·4	35	16	—
24216	—	0·5	14	55	—
24217	—	1·2	39	7–15	—
24218	1·8	0·2	7	50	80
24219	2·0	0·4	4	41	80

fewer and, except for one separating the two parts of the fossil, discontinuous; but this may well be a question of the level of sectioning. The 'main part' is shown as trapezoidal but two portions of this structure are not connected and again it may be a fortuitous preservation of the fractured distal part of the fossil, for which in this case there is no evidence of a network.

Sandvikina sp.

Plate 3, fig. 1

Material. Institute of Palaeontology, University of Modena, no. 24221 (in thin section); locality 36, Dingle Peninsula (see above).

Description. Similar to *S. conica*, but basal cone with a definite thin outer wall and regularly placed longitudinal as well as transverse elements internally. Total length 5·0 mm, length of basal cone 2·6 mm; number of transverse partitions 40, approximate distance apart 0·06 mm; angle of increase of basal cone 10°, angle of increase of distal part 38°. As there is only one section of this form a specific name is not suggested.

Genus REGNELLIA Lauritzen, 1974

Type species. Regnellia camera Lauritzen, 1974.

Regnellia camera Lauritzen, 1974

Plate 3, figs 2–3

1974 *Regnellia camera* Lauritzen, p. 712, pl. 102, figs 2–3.

TEXT-FIG. 3. Sketch of thin section with specimens of *Sandvikina conica* sp. nov., whose distribution is indicated by the grey colour. Institute of Palaeontology, University of Modena: A, holotype, no. 24211; B, no. 24212. Ballynane Member; Dingle Peninsula, Ireland. Trilobite and crinoidal fragments are easily recognizable. Direction of bedding is indicated in the section by the disposition of small levels of detrital quartz grains and is parallel to specimen B. Specimen A is illustrated in Plate 1, figure 1; B, in Plate 1, figure 2; and C, in Plate 2, figure 2.


1 mm
A
B
C

Material. Institute of Palaeontology, University of Modena, no. 24222 (in thin section), locality 36, Dingle Peninsula (see above).

Description. A cylindrical microfossil 3·6 mm in length, with *c.* 80 transverse concave partitions. These bend more steeply towards the outside to give an imbricate impression. Both ends are incomplete. Cross-section unknown. The specimen appears to be the same as the holotype figured by Lauritzen from Norway, and Regnéll's material from Sweden, which the former suggested had a circular cross section.

COMPOSITION

The holotype of *Sandvikina conica* is partially silicified while the Scottish specimen is entirely silicified. The former is calcareous in the basal cone and completely silicified in the distal part. Silicification could easily be explained for the Irish fossil by the abundant tuffs in which the limestones are intercalated. The other Irish material is preserved in a microcrystalline calcareous matrix, which is sometimes slightly locally silicified. Regnéll (1947, p. 1) commented that the fossils 'seem to be so intimately connected with the surrounding rock-matrix that they cannot even be detected in hand-specimens but in slides only'.

STRATIGRAPHICAL DISTRIBUTION

Lauritzen's material is from Aeronian biomicritic limestones, from Sandvika, 12 km west-southwest of the centre of Oslo, Norway. Regnéll's specimens came from a quarry at Kallholn in Dalarna, central Sweden. The rock was described as 'crack-filling in the Boda limestone', suggesting that it 'might not be older than the basal Silurian'. Lauritzen commented further that the fissures are filled with graptolitic shales from the middle Llandovery and that these sometimes contain horizons of dark concretionary limestone. The stratigraphical setting of our own Irish material has been discussed above. The evidence so far suggests that the Regnellidae range from middle Llandovery to Wenlock, or possibly basal Ludlow.

The lowermost exposed Silurian in the Hagshaw Hills (Midland Valley of Scotland) is represented by the Hagshaw Group. The basal units of this are interpreted to be marine turbidites and have been dated as upper Llandovery (Rolfe 1961). The Hagshaw Group is overlain by the Parisholm Conglomerate (Igneous Conglomerate) and contains about 6 per cent of sedimentary clasts which are indistinguishable from those found in the Igneous Conglomerate. Wenlock age fossils have been found in the Igneous Conglomerate (Rolfe and Fritz 1966) and indicate that the age of the source rock for the greywacke clasts is more likely to be Llandovery than Wenlock or younger.

The age of the fossil described above indicates a Silurian age source for the Greywacke Conglomerate and not a pre-Arenig source terrane as previously suggested. The deposition of the Greywacke Conglomerate into locally filled basins suggests that the greywacke source was either autochthonous within the Midland Valley or accreted to the Midland Valley Laurentian margin. As most of the strike-slip movement along the Laurentian margin is believed to have occurred before the end of the Llandovery (Dewey and Shackleton 1984) the simplest model is the accumulation of a relatively thick Llandovery age greywacke within the Midland Valley. The Silurian is poorly exposed in the Midland Valley but occurs in a series of inliers from the southwest to the northeast along the southern margin, where the Llandovery is represented as deep water turbidites. Palaeocurrent data suggest that in the Hagshaw Hills the sediments were derived from the south,

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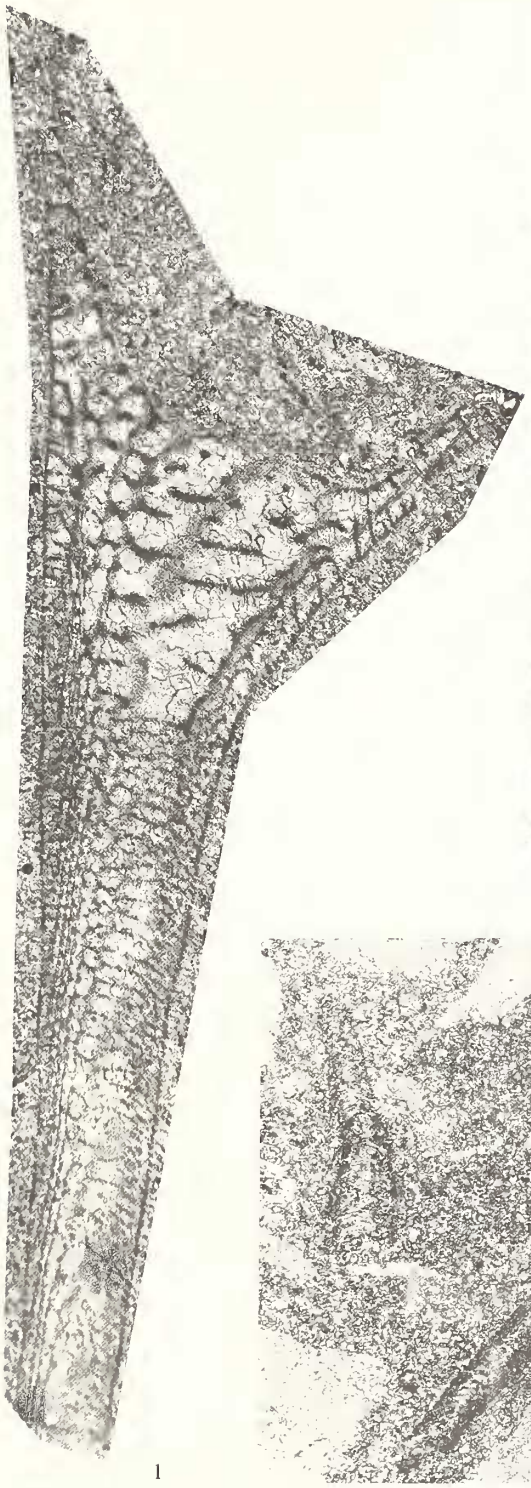
EXPLANATION OF PLATE 3

Fig. 1. *Sanvikina* sp. Institute of Palaeontology, University of Modena no. 24221. Ballynane Member, ×35.
Figs 2–3. *Regnellia camera* Lauritzen, 1974. 2, Modena no. 24222. Ballynane Member; close view of Plate 3, fig. 3. ×135. 3, Modena no. 24222; Ballynane Member, ×25.



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but equivalent formations in the most north-easterly inlier suggest sediment dispersal from the east-north-east. Petrographic and geochemical analysis of the greywacke clasts, along with both a southerly and northerly dispersal pattern in the Llandovery sediments, are consistent with deposition in a mature Midland Valley inter-arc basin.

The source for the Greywacke Conglomerate is now believed to be the Llandovery age sediments in the Midland Valley. These sediments were probably uplifted during Wenlock times and may account for the disconformity seen at the base of the Igneous Conglomerate in the Hagshaw Hills. The deposition of the greywacke conglomerate into separate north–south trending basins, each with a source direction from the east may represent east–west plate interaction between Laurentia and Baltica.

AFFINITY AND FUNCTION

Neither Regnéll nor Lauritzen could present any positive evidence concerning the nature of the organism which produced the fossils described here. We must add that an affinity with the sponges seems improbable as the scale and proportions of the skeletal elements are inappropriate. The fossils remain for the present as problematica.

The Irish and Scandinavian specimens are associated with various groups of shelly fossils, notably brachiopods, bryozoans, echinoderms, and trilobites. Lauritzen recorded the presence of *Girvanella*. With regard to the Irish material, bivalves and gastropods, which generally dominate the near-shore marine environment, are absent, as are typical Silurian pelagic organisms such as the graptolites and nautiloid cephalopods. Similar shallow and well-ventilated water communities, dominated by brachiopod-trilobite-crinoidal associations, are very common in volcaniclastic accumulations, evidencing colonization during minimal supply of volcanic material by explosions or currents. A relatively shallow water environment, rich in detrital material, seems likely, where the water was agitated sufficiently to fragment the various fossils but not to destroy them.

The presence of *R. camera* in different environments led Lauritzen to suggest a pelagic mode of life for the organism. The Irish specimens are associated only with benthic forms, and we are inclined to suggest a benthic mode of life for the Regnellidae also.

Our suggestion is that the basal cone became attached to the substrate and grew apace with sedimentation to provide an effective anchor, upon which foundation the delicate distal network was fixed. This may have functioned in the manner of the skeleton of a sponge in a filter-like system or possibly projections of the soft body emerged from the side. The presence of numerous partitions in the basal cone and their disposition reveal a certain flexibility together with steadiness if subjected to movement by currents. *Regnellia camera* may have grown at greater length obliquely through the sediment as suggested by Hubbard (1970) for the superficially similar, but very much larger, Carboniferous caninioid corals to which she referred. Its distal network, if ever present, remains unknown.

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ANNALISA FERRETTI
Institute of Palaeontology
University of Modena
Via Università, 4
41100 Modena, Italy

CHARLES HEPWORTH HOLLAND
Department of Geology
Trinity College
Dublin, 2, Ireland

ERIKA SYBA
Brigantian Exploration Ltd.
Thatched Cottage
The Green
South Collingham
Newark NG23 7LE, UK

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